康乃馨葉斑病之生態及防治

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摘　要

Alternaria dianthi Stev. & Hall. 所引起的康乃馨葉斑病，是本省康乃馨栽培上最主要的葉部病害。本病原菌除爲害葉片產生黃褐色或紫褐色斑點外，尚可引起枝條枯萎及花苞、花朵出現輪斑或無法展開，嚴重時全株枯萎，影響切花品質及價格甚鉅。本病原菌最適生長之溫度及相對濕度分別爲 24 ～ 28 ℃及 98 ～ 100 %。影響本菌危害康乃馨葉片主要因子爲溫度、濕度及感染源濃度。適宜發病之溫度爲 24 ～ 28 ℃。盆栽試驗顯示，相對濕度愈高，葉斑病發生亦愈嚴重。感染源濃度愈高，病勢進展愈快。按嘉義港坪里之康乃馨栽培區的氣象及葉斑病週年發生的資料顯示，葉斑病之發生與氣象因子有密切的關係，病勢進展與相對濕度、降雨量和降雨累積時數呈顯著正相關。不同品種康乃馨在田間發生葉斑病之程度有明顯差異。溫室檢定 50 個康乃馨品種對葉斑病菌之抗感性，有 8 個品種較抗病。本病原菌可經由種苗及側芽傳播，其帶菌率分別爲 0 ～ 11 %及 0 ～ 65 %。本菌可寄生在醴腸、通泉草、山芥菜及山萵苣等田間雜草上並存活在病株殘體及土壤中。經室內藥劑篩選，選出 75 % Chlorothalonil（四氯異苯腈）W.P. 400X 及 24.9 % Difenoconazole（炭剋）E.C. 1,000X 兩種藥劑進行田間防治試驗，結果顯示，發病前或發病初期施用此兩種藥劑均可有效防治葉斑病，尤以炭剋效果最佳，明顯提高切花之品質與產量。本病害之防治要點如下：*1.*栽培抗病品種。*2.*感病與抗病品種最好分區種植，勿將抗病品種與感病品種混植。*3.*選用健康種苗。*4.*採用設施栽培配合滴灌或畦灌系統。*5.*做好田間衛生工作，徹底拔除病株並集中燒毀，勿丟棄於栽培園畦面或溝旁。*6.*配合氣象的變化，進行適當之藥劑防治。

（關鍵字：康乃馨、葉斑病、生態、防治）

前　言

康乃馨（*Dianthus caryophyllus* L.）原名香石竹，屬石竹科石竹屬一年或二年生之草本植物。西元 1914 年美國將之訂爲母親節之花後，其所代表之意義即廣傳至世界各地，也因而深受群衆喜愛，在國際花卉市場上名列銷售前茅[2]。本省康乃馨約在 20 年前由國外引種於南投埔里地區，

試種成功後，始經濟栽培，後因政府提倡發展精緻農業，更使之蓬勃發展；目前栽培面積已達 50 公頃，主要產區集中在南投縣之埔里鎮與仁愛鄉、彰化縣之田尾與永靖鄉及嘉義市，是本省重要切花花卉之一[(3)]。

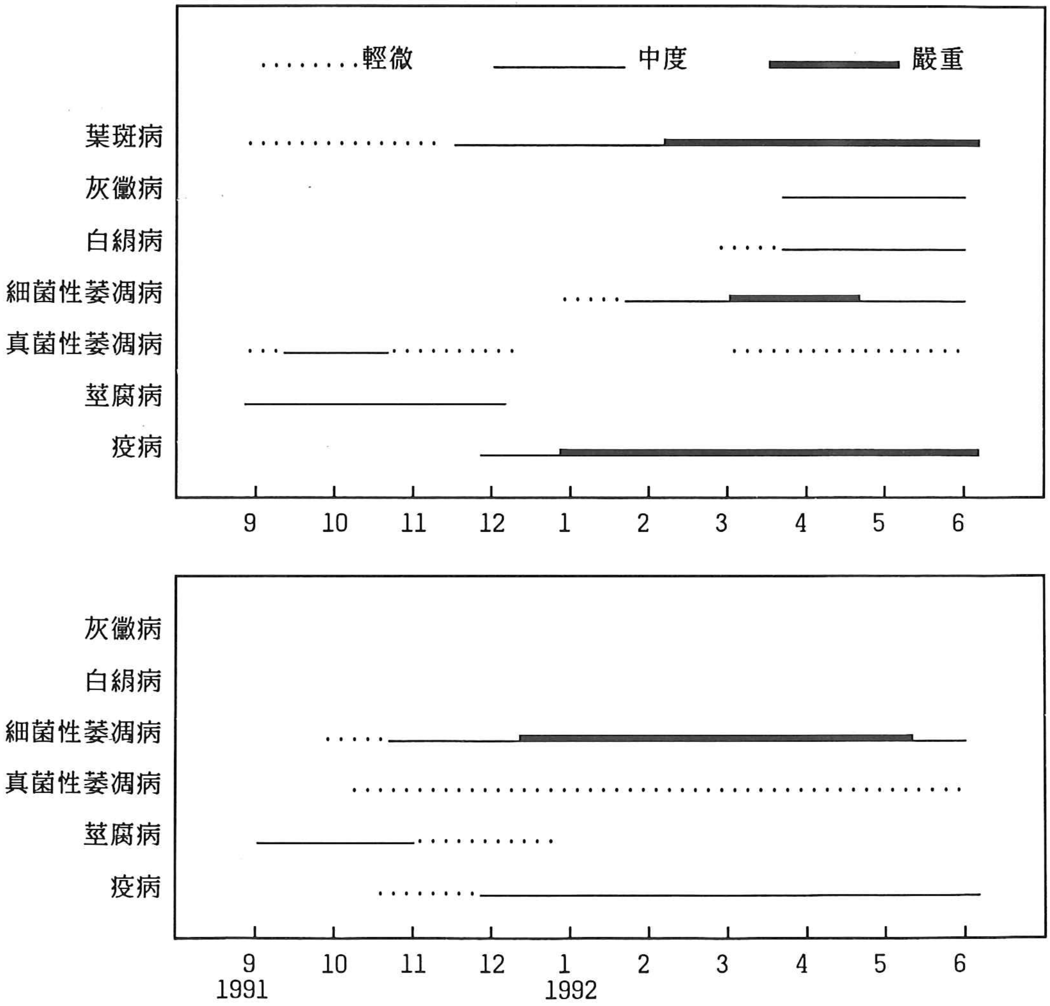
本省康乃馨栽培方式，除了埔里地區架設簡易防雨設施栽培外，其他地區大多採露天栽培。根據筆者等三年來之田間調查，本省康乃馨病害種類多達 14 種（表一），其中以疫病、細菌性與

表一、臺灣康乃馨病害種類
Table 1. Diseases of carnation in Taiwan

Common name	Pathogen	Reference
Alternaria blight or leaf spot （葉斑病）	*Alternaria dianthi* Stev. & Hall *Alternaria dianthicola* Neeng.	(10)
Anthracnose （炭疽病）	*Colletotrichum gloeosporioides* Penzig	
Fairy ring leaf spot （環斑病）	*Cladosporium echinulatum* (Berk.) de Vires	(12)
Bacterial wilt （細菌性萎凋病）	*Pseudomonas caryophylli* (Burkholder) Starr. et Burkh.	(5)
Fusarial wilt （眞菌性萎凋病）	*Fusarium oxysporum* f. sp. *dianthi* Snyd. et Hans.	(11)
Gray mold （灰黴病）	*Botrytis cinerea* Pers. ex Fr.	(9)
Pythium root rot （根腐病）	*Pythium aphanidermatum* *Pythium* spp.	
Phytophthora blight （疫病）	*Phytophthora parasitica* Dastur. *P. capsici* Leonion *P. cryptogea* Petlz. et Laff.	(1)
Rhizoctonia stem rot （莖腐病）	*Rhizoctonia solani* Kuhn	(13)
Southern blight （白絹病）	*Sclerotium rolfsii* Sacc.	(8)
Root−knot nematode （根瘤線蟲病）	*Meloidogyne incognita* *M. javanica*	(6)
Leaf and bud nematode （葉芽線蟲病）	*Aphelenchoides besseyi*	(6)
Sting nematode （釘線蟲病）	*Paratylenus* spp.	(6)
Virus （病毒病）	Carnation mild mosic virus	(4)

眞菌性萎凋病及葉斑病較爲嚴重，苗期常發生莖腐病。露天栽培其病害相及發病程度較簡易塑膠布設施栽培區複雜且嚴重；在多雨的季節，疫病、細菌性萎凋病及葉斑病有較嚴重之趨勢（圖一）。

葉斑病（Alternaria leaf spot or blight）是本省康乃馨栽培上最重要的葉部病害，若疏於防治，常造成全園之毀損，影響產量及切花品質甚鉅。本病之病原菌有二種，一爲 *Alternaria dianthi* Stev. & Hall.，其病原性強，爲害程度較嚴重，嚴重者造成全株枯萎；另一爲 *A. dianthicola* Neeng.，病原性較弱，主要危害花苞，在本省罕見造成嚴重之威脅。本文除描述此二病原菌所起之病徵及其形態外，並針對由 *A. dianthi* 所引起之葉斑病的發生生態及防治作進一步之探討，以供栽培者及有關研究之參考。



圖一、嘉義港坪里地區露天栽培（上）及埔里地區簡易防雨設施栽培（下）康乃馨之病害相。

Fig. 1. Diseases of carnation in open field cultivation at Kang-pign, Chia-yi as compared to those in rain-proof structured house cultivation at Pu-li from Sep., 1991 to Jun., 1992.

病徵及病原菌

主要病徵出現部位在康乃馨葉片及枝條，嚴重時，花苞亦可發現。為害初期，葉片出現紫色或淡褐色（康乃馨品種不同而有差異）之小斑點，病斑擴大後呈圓形斑，中央壞死而呈紫灰色至黃褐色，外緣有明顯之黃綠色暈環，若數個病斑在同一葉片上擴展後，常聯結成大而不規則病斑（圖二－B），嚴重則導致被害葉片枯萎，在潮濕狀況下，病斑上產生黑色的孢子堆。枝條受害大多在節部附近，開始在莖部表面組織形成水浸狀病斑，後病斑擴及莖部內組織，病斑部分與健全組織間之界限明顯，病斑上產生許多黑色孢子堆，最後病組織壞死，枝條枯萎（圖二－C）。花苞或花朵受葉斑病菌感染，初期出現淡褐色小斑點，後形成黃褐色至黑褐色之輪紋斑，嚴重則花苞枯萎無法展開（圖二－D）。本病係由 *Alternaria dianthi* Stev. & Hall. 引起。其分生孢子 (conidia) 為褐色或深褐色，大小為 30 ～ 120 × 10 ～ 25 μm（平均為 64 × 16 μm），喙 (beak) 大小為 2 ～ 11 × 3 ～ 6 μm（平均為 6.9 × 4.4 μm），橫隔數為 3 ～ 6 隔，縱隔數為 1 ～ 3 隔（圖二－A），分生孢子通常 2 ～ 4 個串生在一起，分生孢子梗 (conidiophore) 叢生，偶而單生。

於連續多雨期，本省黃色及粉色系康乃馨偶而可見由 *Alternaria dianthicola* Neeng. 所引起之花腐病，此病原菌主要危害花器，造成花腐 (Alternaria flower rot)，受害花苞或花朵大多呈淡褐色，嚴重者花苞無法展開（圖二－F）。田間很少看見此病原菌危害葉片及枝條。葉片及枝條上的病斑通常是淺黃至淡褐色，形狀為橢圓形，嚴重者數個病斑聯結成數公分大之不規則病斑。其分生孢子梗單生或叢生，分生孢子顏色較淡，為淡褐色，大小為 55 ～ 130(93) × 10 ～ 16(13) μm，橫隔數可達 14 隔，縱隔數為 1 或 2 隔（圖二－E），通常 4 ～ 5 個串生在一起。

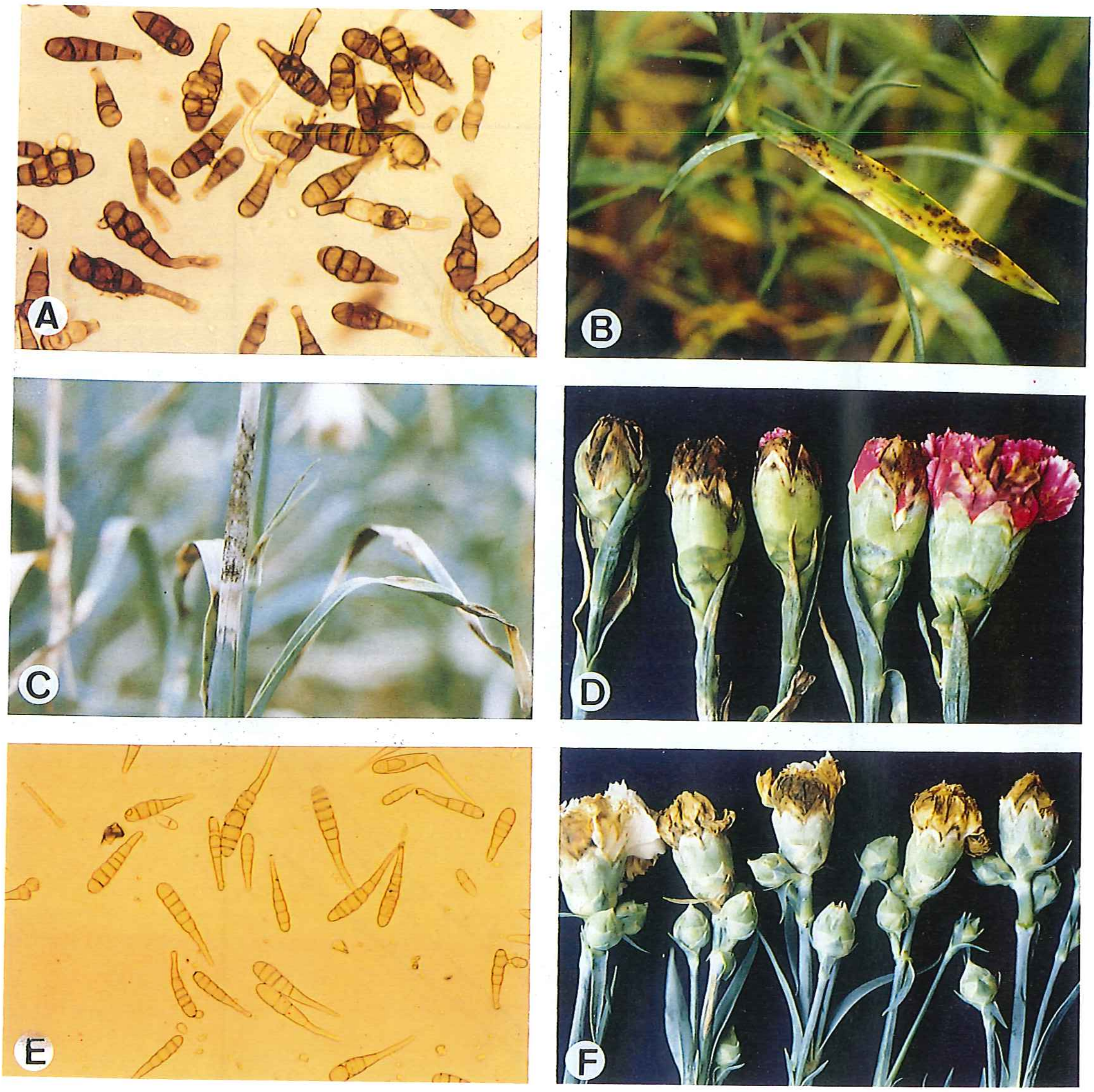
發生生態

一、影響病原菌生長及發病之重要因子

病原菌孢子發芽及菌絲適宜生長之溫度範圍為 20 ～ 28 ℃，以 24 ℃為最適溫度 (10)。病原菌之發芽率及植株之罹病度隨著相對濕度的提高而增加，最適相對濕度為 98 ～ 100 %（圖三）。Strider(30) 報告 *A. dianthi* 在植株上之發病程度與保濕時間有直接關係，Bickerton(16) 亦報告在適溫 (21 ℃) 環境中，若接種環境之保濕時間低於 6 小時，無法顯現病徵。Nisson(27) 於幼齡植株，進行維持 5 天保濕之接種試驗，第 3 天即出現病徵，第 5 天即萎凋。筆者於生長箱進行接種試驗，結果顯示，植株在 25 ℃，相對濕度 100 %下，10 天即導致 100 % 之罹病度，相對濕度 90 %時，則只有 67 %之罹病度（圖三）。以濃度為 10^2 ～ 10^6 conidia/ml 之孢子懸浮液，接種康乃馨葉片，結果顯示，濃度為 10^6conidia/ml 經 3 ～ 5 天，即出現明顯病徵。10^2 conidia/ml 在接種後 10 天，尚未出現病徵，顯示孢子濃度愈高，發病亦較快。Strider(30) 認為光照對本菌之產孢能力幾無影響，然筆者試驗結果，光照乃產孢要件之一，黑暗處理產孢量極少，甚至不產孢。

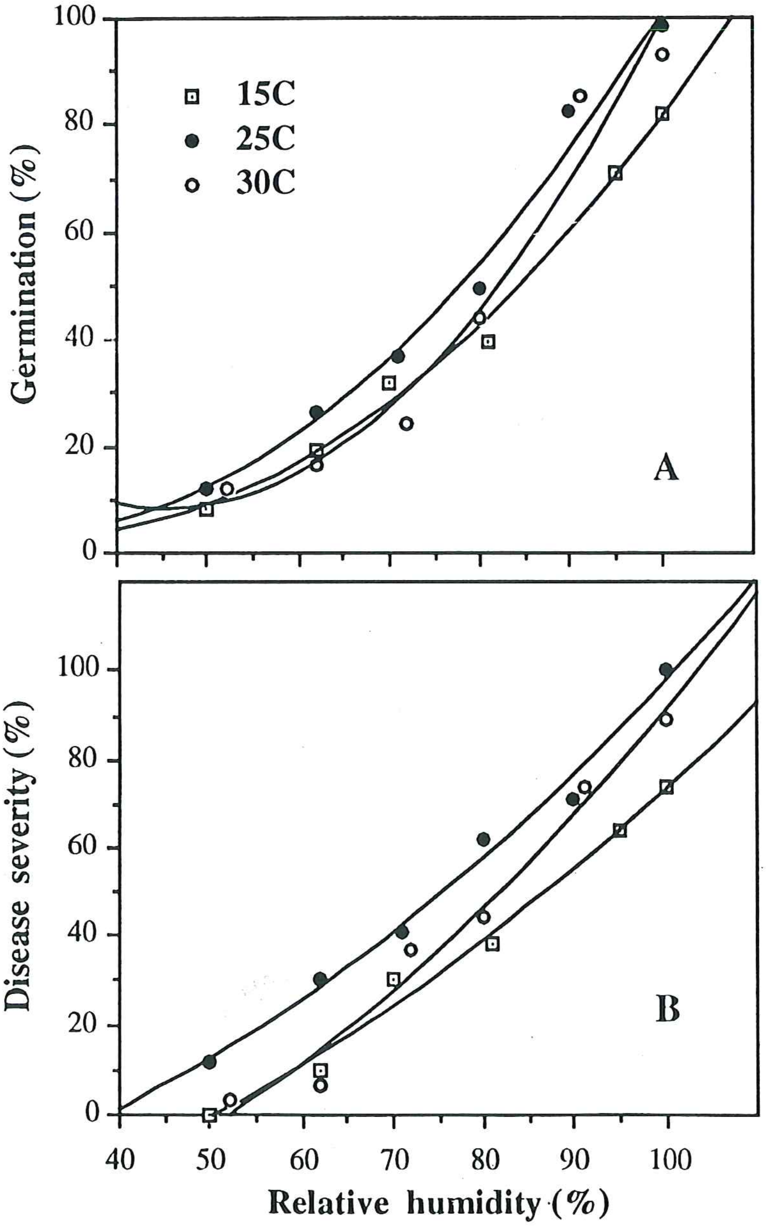
二、田間病害發生消長與氣象因子之關係

為瞭解田間葉斑病之週年發生消長，於嘉義港坪里設置觀察站，自民國 79 年 9 月至 82 年 6 月，每月定期調查感病品種康乃馨 (Scarlette) 葉斑病的發生程度。有關病害罹病度調查如下：將



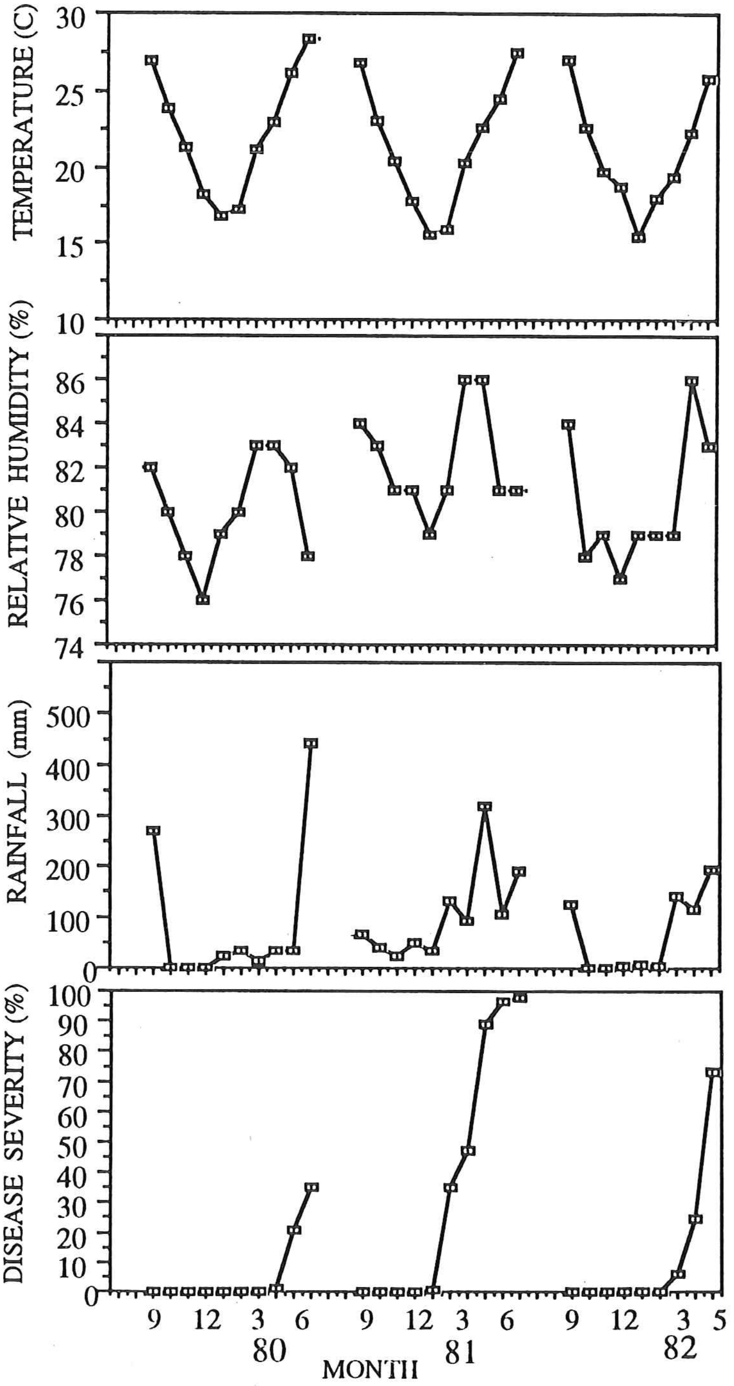
圖二、為害康乃馨葉、枝條及花之葉斑病菌 *Alternaria dianthi*(A), *A. dianthi* 為害葉部之病徵 (B), 枝條罹葉斑病之病徵，其上產生許多黑色的孢子 (C), *A. dianthi* 為害花苞之病徵 (D), 造成康乃馨花腐之葉斑病菌 *Alternaria dianthicola*(E), *A. dianthicola* 在花苞上造成之病徵 (F) 。

Fig. 2. Conidia of *Alternaria dianthi*(A), symptom of leaf infected with *A. dianthi* (B), symptom of stem infected with *A. dianthi* (C), symptom of flower infected by *A. dianthi*(D), conidia of *Alternaria dianthicola*(E), symptom of flower caused by *A. dianthicola*(F).



圖三、相對濕度與溫度對康乃馨葉斑病菌孢子發芽 (A) 及葉片罹病度之影響 (B)。

Fig. 3. Effect of relative humidity and temperature on the conidia germination and disease severity of carnation leaves caused by *Alternaria dianthi*.



圖四、嘉義港坪里康乃馨栽培區溫度、濕度、雨量與葉斑病罹病度之發生消長。

Fig. 4. The fluctuation of temperature, relative humidity, rainfall, and disease severity of carnation leaf caused by *Alternaria dianthi* at Kang–ping, Chia–yi. from Sep., 1990 to June, 1993.

葉片罹病度分爲五個等級

0 級：全葉無病斑者

1 級：病斑面積占全葉 0 ～ 10 ％

2 級：病斑面感染面積在 11 ～ 25 ％

3 級：葉片被感染面積在 26 ～ 50 ％

4 級：葉片被感染面積在 51 ％以上

計算被害度爲：

罹病度（％）＝Σ（發病等級×該等級之葉片數）／ 4 ×調查總葉數× 100 ％

每調查小區各逢機調查 10 株，每株調查心葉以下之五節葉片，計爲 10 片葉。並記錄溫、濕度及雨量之變化。結果顯示，葉斑病逢多雨期發生較爲嚴重，雨期若來得早，則發病亦有提早之現象；9 月至 12 月氣候乾燥，病害罕見發生（圖四）。進行 81 年 1 月至 6 月之病勢進展與氣象因子（包括 16 ～ 20 ℃之累積時數 (X_1)、20.1 ～ 24 ℃之累積時數 (X_2)、24.1 ～ 28 ℃之累積時數 (X_3)、28.1 ～ 32 ℃之累積時銓 、平均溫度 (X_5)、平均相對濕度 (X_6)、80 ～ 85 ％ RH 之累積時數 (X_7)、85.1 ～ 90 ％ RH 之累積時數 (X_8)、90.1 ～ 95 ％ RH 之累積時數 (X_9)、95.1 ～ 100 ％ RH 之累積時數 (X_{10})、90 ～ 100 ％ RH 之累積時數 (X_{11})、降雨量 (X_{12})、降雨日數 (X_{13}) 及降雨累積時數 (X_{14})) 之單因子及複因子迴歸分析，瞭解病勢進展與平均相對濕度 (X_6)，降雨量 (X_{12})，降雨日數 (X_{13}) 及降雨累積小時數 (X_{14})，呈顯著正相關，尤其和降雨量及降雨累積小時數關係最密切 ($p<0.01$)；由複因子迴歸分析程式中，選出 6 個相關係數最高之預測程式（表二）。

三、不同品種之抗感病性測定

Strider[30]，檢測 40 個康乃馨品種對 *A. dianthi* 之感受性，結果均爲感病性。筆者等在適宜發病季節，調查田間栽培區（包括彰化縣之田中、田尾、北斗與溪州及嘉義市之港坪里）株齡爲 7 個月之不同品種康乃馨葉斑病之發生程度，發現品種間之差異頗大，以紅花品系發病較輕微，紫色及雙花色（混合色）系列較爲嚴重（表三）。溫室檢測 50 個康乃馨品種，有 8 個品種較抗病，33 個品種感病，另 9 個品種爲極感病性（表四）。進一步各選擇一抗病、感病、極感病品種（Arine，Scarlette，Tombola）進行田間種植，結果顯示，抗病品種之病勢進展極爲遲緩，感病及極感病性品種則較爲快速（圖五）。經由光學顯微鏡及掃描式電子顯微鏡檢視結果，*A. dianthi* 侵入康乃馨葉片之途徑有二：一是由氣孔直接侵入；其二爲菌絲尖端直接侵入表皮組織。品種間單位面積氣孔數與罹病度無直接之相關性。

四、傳播與存活

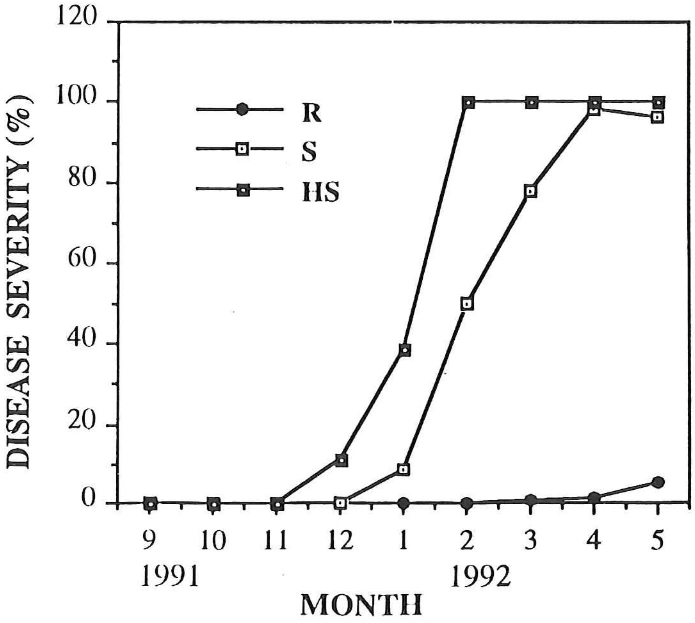
本病害之初級感染源，一般認爲來自種苗或種子[14]。Skiver[29] 曾報導因種苗帶菌而致病害嚴重流行之案例。筆者自進口之國外種苗抽檢 12 個樣本，進行檢測，結果僅有一個來自日本之種苗有 11 ％之帶菌率（表五），本田期亦有發病之現象。本省農友常摘取田間康乃馨生長茂盛期之側芽，繁殖第二代苗，收集農友摘取之側芽檢測其平均帶菌率爲 16 ％ (0 ～ 65 ％)，因品種而有差異（表六），若值多雨季節，此亦是造成病原菌在田間傳播蔓延之主因。*A. dianthi* 之寄主範圍大都侷限於石竹屬 (Dianthus) 植物，少數寄主爲其他石竹科 (Caryophyllaceae) 植物，如滿天

表二、嘉義港坪里康乃馨葉斑病病勢進展與氣象因子之關係

Table 2. The correlation of weather condition at Kang-ping with the development of disease severity of carnation leaf caused by *Alternaria dianthi*

Regression equation[1]	Determination coeffecient(r^2)
$Y=-86.49+1.1X_6$	0.31*[2]
$Y=0.32+0.18X_{12}$	0.67**
$Y=-2.36+2.79X_{13}$	0.36*
$Y=0.48+0.36X_{14}$	0.52**
$Y=0.36-0.07X_1+0.1X_8+0.18X_{12}$	0.71**
$Y=-22.67-0.06X_1+0.32X_6+0.16X_{12}$	0.69**
$Y=-15.69-0.05X_2+0.22X_6+0.18X_{12}$	0.69**
$Y=1.80-0.05X_2-0.01X_{10}+0.2X_{12}$	0.68**
$Y=1.48-0.05X_2+0.01X_{11}+0.19X_{12}$	0.68**
$Y=-4.59+0.2X_4+0.11X_8+0.18X_{12}$	0.70**

1. Y:increasing disease severity, X_1:Accumulated hours of 16–20C, X_2:Accumulated hours of 20.1–24C, X_4:Accumulated hours of 28.1–32C, X_6:Average relative humidity, X_8:Accumulated hours of RH 85.1%–90%, X_{10}:Accumulated hours of RH 95.1%–100%, X_{11}:Accumulated hours of RH 90%–100%, X_{12}:Percipitation, X_{13}:Days of raining, X_{14}:Accumulated hours of raining.
2. *Significant at 5% level, ** significant at 1% level



圖五、抗病、感病及極感品種康乃馨在田間之葉斑病病勢進展。

Fig. 5. The development of Alternaria leaf spot on resistant(R), susceptible(S), and highly susceptible(HS) carnation cultivars in the field.

表三、田間不同品種康乃馨葉斑病之發生情形

Table 3. Field occurrence of leaf spot disease caused by *Alternaria dianthi* on various carnation cultivars

Cultivar[1)]	flower color	Disease severity(%)	
		leaf	flower
hgr Ariane	red	1.2	0
Nelson ngr	red	2.5	0
Rony tgr	red	4.3	0
Carrera	pink	0	0
hgr Stefanie	pink	33.8	59
Nathalie	pink	12.2	18
hgr Barbara	pink	9.6	12
Ramona	cerise	30.0	57
しナズパ	cerise	8.8	12
hgr Natila	cerise	35.6	52
Salamanca	yellow	28.5	55
Alpine stapin	white	22.2	65
Cabaret	orange	18.4	21
Izmir nbgr	purple	76.9	81
nbgr Ettore	red/white	87.3	92
hgr Scarlette	red/white	53.6	68
Scarlette Queen	red/white	59.0	73
wgr Graffiti	white/red	0.5	0
hgr Tombola	white/pink	73.8	81
ngr Nibbio	white/light pink	20.4	34
hgr Festival	yellow/red	26.9	48

1)The carnation plant was 7-month-old.

星類(*Gypsophila* spp.)和皂質草(*Saponaria* spp.)，亦有見於其他植物上[17]。筆者自田間採集可疑病徵之雜草，進行分離及接種試驗，結果顯示，本菌能寄生在醴腸、通泉草、山芥菜及山萵苣等植物(表七)。

康乃馨葉斑病菌孢子之傳播途徑主要經由飛濺的水[18]。因水份(miosture) 是本病蔓延之一重要因子，而繁殖種苗通常須維持在高濕度環境中一段時間，致種苗帶菌亦可能將此病害傳播至其他栽培區。溫室或設施栽培之康乃馨，若採噴霧灌溉系統，利於本病原菌之傳播。本省霧社康乃馨栽培園葉斑病之流行即爲一例。另露天栽培區，於多雨期，因飛濺之雨水，亦助長病勢之蔓延。

本病原菌可存活在種子、病株殘體及土壤中[17]。DeTempe[19]曾報告康乃馨種子有2%攜帶病原菌 *A. dianthicola* 之案例。Bickerton[16]證明 *A. dianthi* 能在土壤中越冬，致隔年再種植之康乃馨受害。筆者亦於田間發現農友將嚴重之罹病殘株丟棄於畦面而致病害蔓延之例。

表四、溫室不同品種康乃馨葉斑病之抗感病性反應

Table 4. Susceptibility of carnation cultivars to *Alternaria dianthi* in greenhouse

Cultivar	Disease severity(%)[1)]	Rating[2)]
Vivasim	33.2	S
Espana starotang	21.6	R
hgr Ariane	24.5	R
Indios nbgr	35.9	S
Nelson ngr	39.8	S
hgr Red barbara	33.4	S
Rony tgr	29.1	S
Dona bre	36.8	S
Carrera	20.5	R
hgr Stefanie	53.8	HS
hgr Barbara	36.7	S
Serenode	46.5	S
Nathalie	34.9	S
Tasman nbgr	27.1	S
Ramona nbgr	48.5	S
Manon ngr	35.2	S
レナズパ	27.9	S
hgr Natila	45.5	S
Candy klelopi	16.2	R
Jose	23.0	R
Gala nbgr	35.7	S
Las palmas	29.8	S
ngr Isac	32.0	S
Candy klemaxi	45.7	S
Salamanca	38.5	S
Alpine stapin	41.0	S
hgr White barbara	47.6	S
Cabaret	43.3	S
hgr Tropic sun	28.9	S
Izmir nbgr	68.9	HS
Green castle kgr	40.4	S
Rosita charmeur	46.4	S
nbgr Ettore	54.9	HS
hgr Scarlette	48.1	S
wgr Graffiti	12.2	R
hgr Tombola	70.5	HS
ngr Nibbio	29.1	S
Mistral nbgr	38.2	S
Emanuel	23.3	R
hgr Festival	66.5	HS
Maragia	72.0	HS
Riggio	60.2	HS
Desid	60.1	HS
Safari	58.0	HS
Icaro	40.2	S
Desirade	32.0	S
Curacao	29.0	S
Calando	20.1	R
Master	28.4	S
Oriana	26.9	S

1)The data were recorded 14 days after inoculation and inoculum density was 10^4 conidia/ml.

2)R represents disesae severity of carnation leaves (DS)<25%, S represents 25%<DS <50%, and HS represents DS>50%.

表五、國外進口康乃馨種苗之帶菌率

Table 5. The infection ratio of carnation cuttings imported from abroad by *Alternaria dianthi*

Cultivar[1)]	Color	Infection ratio (%)
hgr Ariane	red	0[1)]
Nelson ngr	red	0
Rony tgr	red	0
hgr Stefanie	pink	0
hgr Barbara	pink	0
hgr Natila	cerise	0
レナズパ	cerise	11
hgr Tropic sun	orange	0
Alpine stapin	white	0
hgr Scarlette	red/white	0
hgr Tombola	white/pink	0
hgr Festival	yellow/red	0

1)The data were recored at 14 days after incubation.

表六、田間康乃馨側芽帶菌率

Table 6. The infection ratio of carnation cuttings produced domestically by *Alternaria dianthi*

Cultivar[1)]	Color	Infection ratio (%)
hgr Ariane	red	8[1)]
Nelson ngr	red	0
Rony tgr	red	0
red Barbara	red	13
Carrera	pink	0
Nathalie	pink	21
Salamanca	yellow	19
hgr Natila	cerise	9
Alpine stapin	white	4
hgr Scarlette	red/white	46
hgr Tombola	white/pink	65
hgr Festival	yellow/red	7

1)The data were recored at 14 days after incubation.

表七、 葉斑病菌對田間雜草之病原性測定

Table 7. Pathogenecity test of *Alternaria dianthi* to weeds commonly found in carnation field

Plants		Pathogenecity of *Alternaria dianthi*
Portulaca oleracea L.	馬齒莧	–
Erechtites hieracifolia (L.) RAf. ex DC.	昭和草	–
Cynodon dactylon (L.) Pers	狗牙根	–
Amaranthus viridis L.	野莧	–
Solanum nigrum Linn.	龍葵	–
Erigeron bonariensis L.	野塘蒿	–
Graphalium purpureum L.	鼠菊舅	–
Rorippa indica(L.) Hiern.	山芥菜	+
Chenopodium ficifolium Sm.	小葉灰藋	–
Oxalis corniculata L.	酢醬草	–
Soliva anthemifolia R. Br.	假土金菊	–
Ageratum houstonianum Mill.	紫花藿香薊	–
Stellaria aquatica(L.) Scop.	鵝兒腸	–
Polygonum plebeium R. Br.	節花路蓼	–
Paspalum conjugatum Berg.	兩耳草	–
Iactuca indica L.	山萵苣	(+)
Eclopta prostrata L.	醴腸	(+)
Eleusine indica(L.) Gaertn.	牛筋草	–
Echinochloa colona(L.) Link	芒稷	–
Mazus pumilus (Burn. f.) Steenis	通泉草	+

[1] – :*A. dianthi* failed to infect the test plants;
+ :symptom appeared after inoculation of *A. dianthi*;
(+):pathogenecities were confirmed by isolation of *A. dianthi* from plants collected in carnation fields.

防　　治

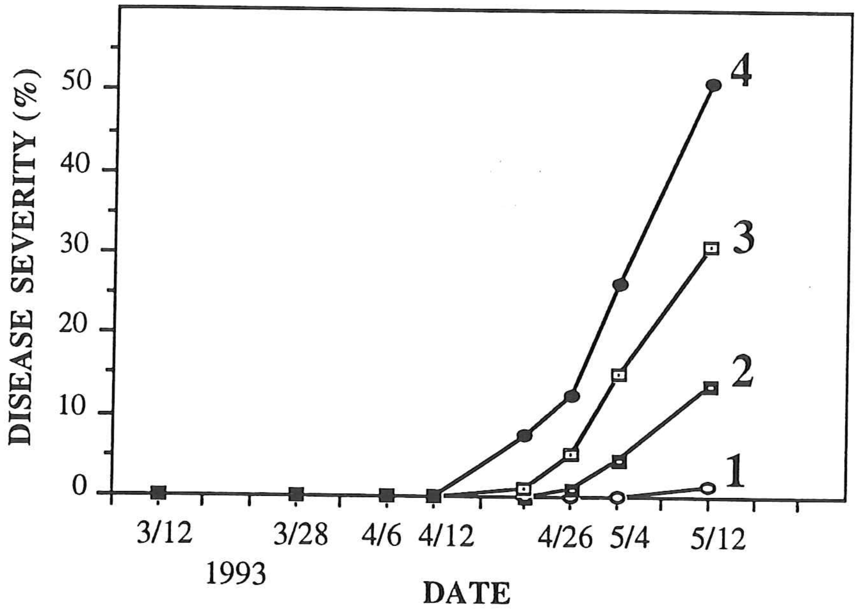
一、良好之栽培管理

1. 栽培抗病品種

在所調查及測試之康乃馨品種中，發現紅花系列較抗病，紫色及雙花色系列較感病，因此選種時宜儘量避免種植感病品種。若要同時種植者，最好將感病與抗病品種分區種植，圖六顯示，若將抗病品種與感病品種採混植或隔行混種，逢適宜發病季節，會加劇抗病品種之病勢進展。

2. 選用健康之種苗

農友常摘取康乃馨之側芽繁殖第二代苗，病原菌容易經由扦插苗攜帶至本田，栽植時須注意選擇無病地區或自健康母株摘取側芽，若苗床發現病苗應拔除或選用適當藥劑防治，此外育苗場所應注意濕度之變化，避免植株葉片水分之累積。



圖六、抗葉斑病康乃馨品種於不同種植方式下其葉斑病病勢進展差異。

Fig. 6. The effect of different mix–planting pattern between resistant and susceptible carnation cultivars in the field on the Alternaria leaf spot disease development in resistant cultivar. The experiment was conducted at Kang–ping, Chia–yi in 1993. The development of Alternaria leaf spot disease severities in resistant cultivar "Arine", when it was mixed planted by three different patterns in the field with a susceptible one "Scarlette", were rated continuously in a period of 2 months. Line 1 (○—○) indicates the development of Alternaria leaf spot disease severiteis in the field planting with cultivar "Arine" alone. Line 2 (□—□) indicates those in the field which Arine and Scarlette were planted respectively in two separate and equal sized plots. Line 3 (⊡—⊡) indicates those when Arine and Scarlette were planted as row by row pattern. Line 4 (●—●) indicates those when Arine and Scarlette were mixed planted in the field as plant by plant pattern.

*3.*採用設施栽培配合滴灌或畦灌系統

本病害主要發生於高濕環境，採防雨之設施栽培，除可提升切花品質外，亦可降低本病之發生程度，若配合滴灌或畦灌系統，更可減少病害之傳播與蔓延，如埔里地區之康乃馨罕見葉斑病之發生（圖一）。在霧社設施栽培之康乃馨有因採噴霧灌溉，致葉斑病流行之例。

*4.*勿密植，做好田間衛生工作

加大畦距或減少密植程度，將有助於降低植株間之相對濕度，進而減少病害之發生。若發病嚴重時，應徹底拔除病株，集中燒毀，勿丟棄於栽培園畦面或溝旁，否則事倍功半。

二、藥劑防治：

在病害防治上，以藥劑防治最爲經濟、快速，因此常被使用於防治葉部病害。由於本病並無任何推薦藥劑可供防治參考，故進行室內藥劑篩選（表八），選擇 75 % Chlorothalonil（四氯異苯腈）W.P. 400X 及 24.9 % Difenoconazole（炭剋）EC 1,000X 兩種藥劑進行田間防治試驗，結果顯示，發病前或初期施用此兩種藥劑均可有效防治葉斑病，尤以炭剋效果較佳。罹病度可由 73.8 %降爲 1.0 %（表九），花苞感染率亦可由 61 %降至 7 %（表十），切花之品質及收益均較對照組顯著提高（表十一）。若發病較嚴重者，宜增加噴藥劑次數。國外亦有諸多有效藥劑之報告[15,21,24,25,28]，如鋅錳乃浦 (Dianthe−45)、鋅乃浦 (Zineb)、錳乃浦 (Maneb)、四氯異苯腈 (Chlorothanil)、益穗 (Thiram) 及依普同 (Iprodine) 等，Wu[32] 報告，億力 (Benomyl) 對葉斑病有防治效果，然 Engelgard[20] 及 Manning[26] 之田間試驗卻指出，若土壤或植株經億力處理過，*A. dianthi* 易建立其族群，葉斑病之發生較爲嚴重，建議栽培康乃馨若有使用億力者，宜注意葉斑病之防治。二者相反的結果，仍有待進一步探討。

結　　語

葉斑病曾經是美國康乃馨栽培事業主要障害之一，近數十年來因大多採行溫室栽培，罕見此病害之流行，偶而可見其發生於採行噴霧灌溉系統之栽培園，因水份之累積，助長病原菌之傳播與蔓延[14,22]。本省地處亞熱帶及熱帶地區，屬海島型氣候，康乃馨開花期正值本省溫暖多雨季節；又本省之康乃馨大多採露天栽培，若疏於預防病害之發生，常造成此病害之猖獗。葉部病害的發生往往與氣象因子有密切的關係，諸多報告[7,23,31]指出，氣候條件的相關係數值，可應用於病害的預測，進而找出最佳防治時機。按嘉義港坪里康乃馨栽培園之氣象資料與病勢進展之統計分析結果顯示，病勢進展與氣象因子有密切之關係，尤與降雨量及降雨累積小時數呈極顯著正相關 ($p<0.01$)；另由複因子迴歸分析中，選出之 6 個預測程式，尚有待一步之田間驗證。因本病原菌主要藉水傳播，又鑑於葉斑病在高溫多雨季節，爲害之猖獗，因此建立一套有效的防治方法，以供農民使用，實爲當務之急。歸結各項試驗結果，若能栽培抗病品種或感病品種與抗病品種分區種植，配合氣候之變化，於適當時期噴藥，加強預防之觀念，早期防治，方可杜絕此病害之發生與蔓延；若是溫室或設施栽培者，最好能採用滴灌或畦灌給水系統，若採噴霧灌溉系統者，應注意室內濕度之變化，避免植株葉片水分之累積。

表八、殺菌劑對康乃馨葉斑病之防治效果(溫室試驗)

Table 8. Greenhouse test on the effect of fungicides on leaf spot disease of carnation caused by *Alternaria dianthi*

Fungicides	Concentration (ppm)	Disease severity (%) A[1]	Disease severity (%) B[2]
	750 (1000X)	14.7 bcde[3]	18.7 efgh
75% Chlorothalonil W.P.	1071 (700X)	12.0 bcde	16.0 efgh
	2500 (300X)	5.3 bcde	9.3 gh
	800 (1000X)	14.7 bcde	21.3 efg
80% Metiram W.P.	1060 (750X)	5.3 bcde	21.3 efg
	2666 (300X)	6.7 bcde	8.0 h
	250 (2000X)	38.6 a	37.3 abc
50% Iprodine W.P.	375 (1500X)	18.7 b	28.0 abcd
	500 (1000X)	8.0 bcde	11.0 gh
	166 (1500X)	1.0 cef	13.0 fgh
25.9% Difenoconazole E.C.	250 (1000X)	1.0 cef	6.0 h
	500 (500X)	0.0 f	6.0 h
	375 (1000X)	18.7 b	36.0 abcd
37.5% Cupric hydroxide W.P.	750 (500X)	18.7 b	24.0 def
	1875 (200X)	8.0 bcde	16.0 efgh
	106 (2000X)	48.0 a	40.0 ab
21.2% Imazalil E.C.	141 (1500X)	17.3 bcd	28.0 abcd
	212 (1000X)	14.7 bcde	25.0 cdef
	650 (1000X)	18.7 b	34.7 abcd
65% Zineb W.P.	1300 (500X)	17.3 bc	27.0 bcde
	3250 (200X)	12.0 bcde	11.0 gh
CK		40.0 a	41.0 a

[1] Fungicides were treated before inoculation of *A. dianthi*.

[2] Fungicides were treated 48 hours post inoculation of *A. dianthi*.

[3] Data followed by the same letter in each column are not significantly different(p=0.05) according to Duncan's multiple test.

表九、田間康乃馨葉斑病防治效果（霧社）

Table 9. Effect of fungicidal treatments for controlling Alternaria leaf spot disease of carnation in the field(Wu–sir)

Cultivar	Treatment[1)]	Disease severity (%) Weeks after treatment 0	2	4	6
Orange triumgh	CK	4.0a[2)]	4.5a	33.3a	73.8a
doranja	75% Chlorothalonil(400X)	4.2a	1.0b	2.8b	5.0b
	24.9% Difenoconazole(1000X)	4.2a	1.1b	1.1b	1.0c
Light pink	CK	4.5a	4.7a	9.2a	63.4a
Candy klelopi	75% Chlorothalonil(400X)	4.0a	1.0b	0.8b	3.5b
	24.9% Difenoconazole(1000X)	4.2a	1.0b	0.6b	2.1b

1)The cultivars were treated with fungicide once a week from April, 1–May,11., 1991.

2)Data followed by the same letter in each column are not significantly different (p =0.05) according to Duncan's multiple test.

表十、田間康乃馨葉斑病防治效果（嘉義港坪里）

Table 10. Effect of fungicidal treatments for controlling Alternaria leaf spot disease of carnation seedling in the field (Kang–ping)

Cultivar	Treatment[1)]	Disease severity (%) Weeks after treatment 0	1	3	Infection % of flower
	CK	8.0a[2)]	15.2a	18.8a	52
Nibbio	75% Chlorothalonil(400X)	7.8a	3.5b	2.6b	11
	24.9% Difenoconazole(1000X)	8.2a	2.0b	1.6b	8
	CK	21.7a[2)]	28.9a	42.7a	61
Alpine	75% Chlorothalonil(400X)	21.2a	14.0b	5.0b	18
	24.9% Difenoconazole(1000X)	22.3a	13.8b	4.6b	7

1)The cultivars were treated with fungicide once a week from Feb. 10,–Feb. 24, 1992.

2)Data followed by the same letter in each column are not significantly different (p= 0.05) according to Duncan's multiple test.

表十一、康乃馨葉斑病防治效益評估（嘉義港坪里）

Table 11. Comparison of disease incidence, yield and profit of carnation between chemical control(24.9% Difenoconazole) and non-contorol

Treatment	Disease[1] severity (%)	% of[1] infected flower	Yield (P/o.1ha)	Unit price (NT/P)
Control				
A[2]	1.2	9	84,094	5.0(2-7.5)
B	3.1	14	79,510	4.4(2-8.0)
CK				
A	36.5	63	51,430	2.6(1.5-6.0)
B	63.5	78	38,854	2.3(1.5-5.5)

1)The data was taken at 6 weeks after fungicide treatment.

2)The experiment was conducted at two 0.05 ha carnation fields(A and B) at Kang-ping, Chya-yi, in 1992.

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Ecology and Control of Alternaria Leaf Spot on Carnation

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ABSTRACT

Alternaria leaf spot caused by *Alternaria dianthi* Stev. & Hall. was the most serious air–borne disease on carnation in Taiwan. The pathogen normally caused purple or straw colored spots on the leaves at the early stage of disease development and subsequently followed by producing dry rots and necrosis on the stems as well as floral parts. Under severe infection conditions, the whole carnation plant could be damaged completely by the fungus and resulted lethal wilting symptoms. Commercial qualities of the flowers and its prices were seriously reduced due to this disease. The optimum temperature and relative humidity for the pathogen's mycelial growth and condial germiantion were at 24–28 ℃ and 98–100%, respectively. Similarly, the optimum temperature and relative humidity for the disease development were also 24–28 ℃ and 98–100%, respectively. Artificial inoculation tests in growth chamber showed that the disease development was positively correlated with the higher inoculum dinsity applied. Under field conditions, there was also a singificantly positive correlation between the disease development and relative humidity, rainfall, and accumulated hours of raining. Commercial carnation cultivars showed variable susceptibilities to this disease in the field. Of 50 cultivars screened in the greenhouse, 8 were recongnized as resistant ones. It was found that the disease could be transmitted through *A. dianthi* contaminated carnation cuttings imported from abroad or porduced domestically and as high as a 65% of contaminating ratio was recorded. Besides carnations, weeds commonly found in carnation fields such as *Eclopta prostrata*, *Mazus pumilus*, *Rorippa indica*, and *Iactuca indica* could also be attacked by the pathogen and served as natural inoculum sources. Spraying with 75% Chlorothalonil W.P. 400x or 24.9% Difenoconazol EC 1,000x

before or immediately after disease occurrence was found effective enough to control the disease in the fields and consequently resulted significantly higher quality of carnations. In general, the following control strategies were recommanded for integrated control of this disease: (1) planting resistant cultivars; (2) susceptible cultivars should not be planted together with resistant ones; (3) planting with cutting contaminated with *A. dianthi* should be avoided; (4) improving carnation production under rain-proof structured house matching with dipping irrigation system; (5) sanitation of carnation fields should be strictly carried out; (6) spraying with effective fungicides properly based on changes of weather condition.

(Key words: Alternaria leaf spot, ecology, control, carnation)